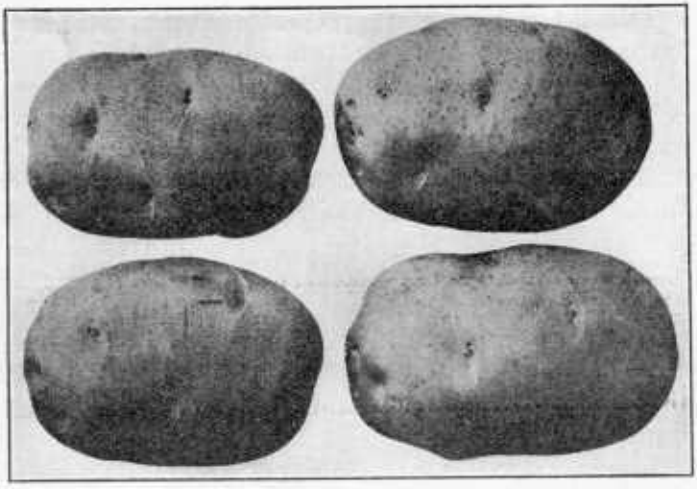
FARMERS' BULLETIN 533

GOOD SEED POTATOES AND HOW TO PRODUCE THEM



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UNITED STATES
DEPARTMENT OF AGRICULTURE

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THE AVERAGE PRODUCTION per acre of potatoes in the United States is very much lower than in Canada, Great Britain, and European countries outside of Italy.

One of the reasons for the lower production in the United States is that less attention has been given to the chaacter of the seed. Good seed is one of the determining factors in the production of maximum crops of potatoes.

The use of high-grade seed would increase the returns from the potato crop of the country by many millions of dollars.

The production of high-grade seed should be regarded as a special business.

Good strains of seed may be obtained by the tuber-unit, hill, or mass-selection methods through the process of roguing out the diseased and weak hills.

When tubers from diseased or weak plants are planted, a similar harvest will be reaped.

Only seed from productive plants should be used.

Careful attention should be given to securing seed that is free from varietal mixture and that is true to type.

Good seed can not be produced unless the growing plants are given good cultural attention.

As a rule the quantity of seed used is not sufficient to produce a maximum crop.

From 15 to 18 bushels of seed should be used per acre instead of 9 to 11, as at the present time.

All seed stock should be disinfected before planting.

Good storage conditions are essential to insure sound, firm seed at planting time.

Contribution from the Bureau of Plant Industry
WM. A TAYLOR, Chief

Washington, D. C.

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GOOD SEED POTATOES AND HOW TO PRODUCE THEM.

CONTENTS.

YIELDS OF POTATOES.

A STUDY of the statistical data upon potato crop production in the United States for the last 50 years[1] reveals the interesting fact that during the first 5-year period, 1868–1872, the average per acre yield in bushels was practically the same as that of the last 5-year period, 1913–1917, the yield for the earlier period being 94.8 as against 95.7 bushels for the latter cycle. The intervening 5-year periods show a fairly uniform decline in each direction, reaching its lowest level between 1888 and 1892. This period happens to be the intermediate one of the 5-year cycles studied. We are practically at the same point in acre production as were our forefathers. Our increased production has therefore been due to larger acreage rather than to higher yields.

Table I shows and the accompanying diagrams (figs. 1 to 4) also show in a graphic way the average acre yields, the farm price per bushel, the acreage grown, the total production of potatoes, and also the population of the United States during the ten 5-year cycles studied. In the construction of these diagrams it has not been feasible to employ the same scale in any two of them, owing to the great difference in the magnitude of the figures treated. A careful study of the first diagram (fig. 1), in which the acreage yield and farm price per bushel are given, shows that the acreage-production curve, if drawn on the chart, would somewhat resemble the curve of a scimitar blade, in which the extreme ends of the blade represent the maximum yields for each half of the curve.

[1] Statistics of the principal crops—Potatoes. *In* U. S. Dept. Agr. Yearbook, 1917, p. 657. 1918.

TABLE I.—*Averages of acre production, bushels per acre, and farm price for potatoes, in 5-year periods, 1868 to 1917.*

5-year period.	Number of acres.	Production (bushels).		Farm price per bushel.
		Total.	Per acre.	
				Cents.
1868–1872	1,246,200	117,745,800	94.8	54.9
1873–1877	1,529,800	134,773,200	88.0	53.3
1878–1882	1,934,200	150,706,200	78.4	59.5
1883–1887	2,284,000	175,197,800	76.9	48.3
1888–1892	2,619,200	193,325,000	73.7	50.7
1893–1897	2,720,000	213,461,800	77.8	44.6
1898–1902	2,716,000	220,849,400	81.2	49.5
1903–1907	3,014,200	289,399,800	95.9	56.3
1908–1912	3,566,400	343,587,600	96.1	62.3
1913–1917	3,813,600	366,131,200	95.7	89.6

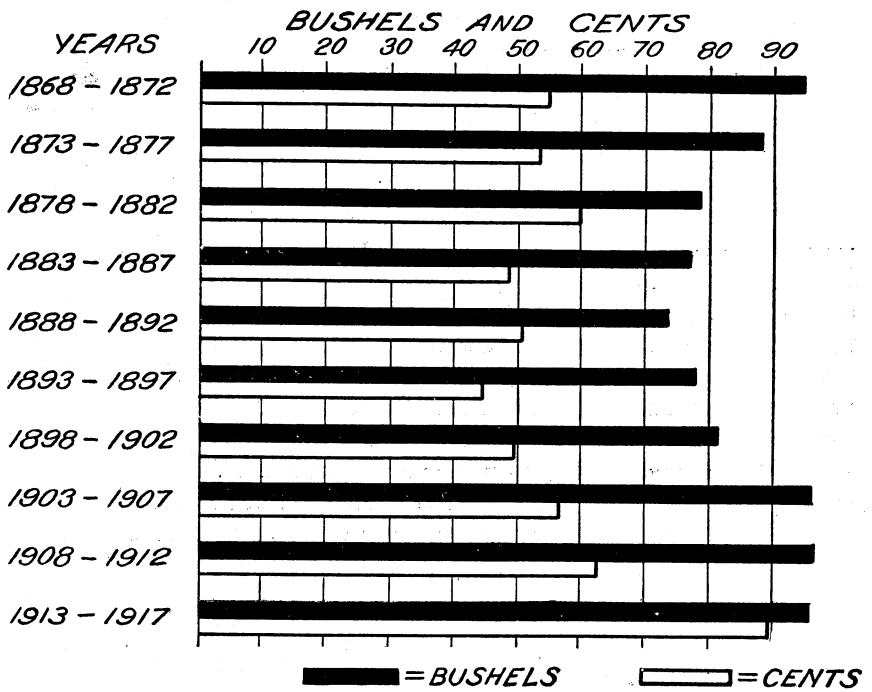

FIG. 1.—Diagram showing the average number of bushels per acre and the average farm price per bushel of potatoes grown in the United States, by 5-year periods, 1868 to 1917.

The gradual decline in yields during the first half of this period is thought to be largely due to the following factors:

(1) The ravages occasioned by the Colorado potato beetle during the early period of its invasion of the eastern United States.

(2) The financial depressions of 1877 and 1893, which brought about a well-marked decline in agriculture in New England, New York, and the other heavy potato-producing areas of the northeastern United States.

(3) A gradual depletion of soil fertility.

Of the factors which have checked the downward tendency and contributed most largely toward a return to the old production level the following are thought to have been most potent:

(1) The influence of the agricultural experiment stations, agricultural colleges, and the United States Department of Agriculture through experimentation, demonstration, and the dissemination of literature.

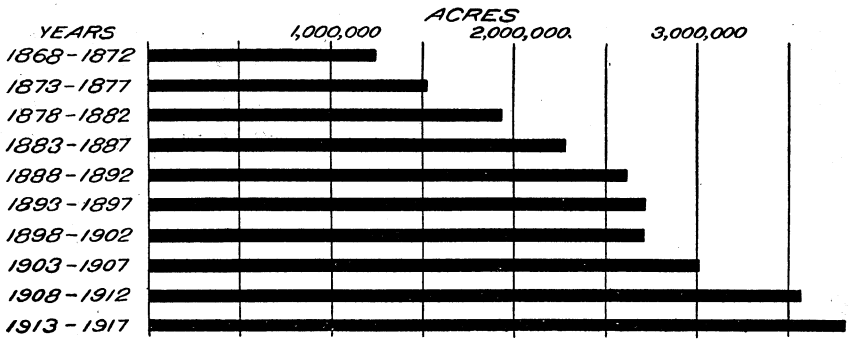

FIG. 2.—Diagram showing the average potato acreage of the United States, by 5-year periods, 1868 to 1917.

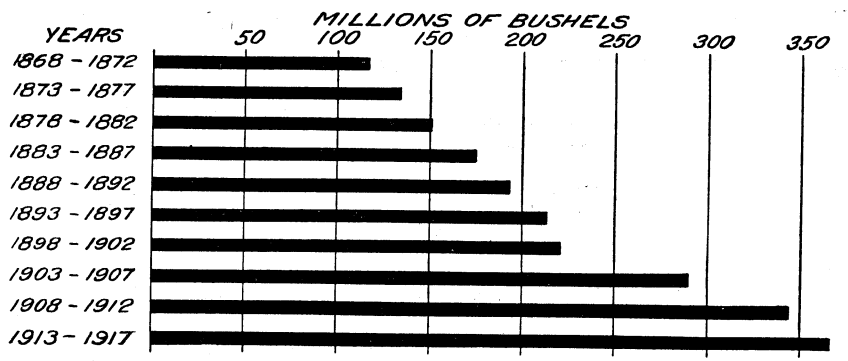

FIG. 3.—Diagram showing the average potato production of the United States, by 5-year periods, 1868 to 1917.

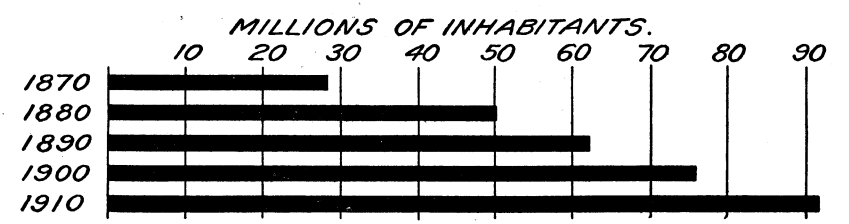

FIG. 4.—Diagram showing the population of the United States, by decades, 1870 to 1910.

(2) The influence of the Bordeaux-mixture treatment in the control of fungous diseases affecting the potato.

(3) The development of special potato-growing sections, as, for example, Aroostook County, Me., the Atlantic Coastal Plain trucking region, the Greeley and Carbondale districts of Colorado, and many other areas, in which the average yield is approximately from two to three times the general average for the United States.

Figures 1 to 4 show a comparison of the relation of increased production to a constantly increasing population. The diagrams show that under normal conditions production is keeping pace with population. Crop shortages are, therefore, the result of abnormal or unfavorable conditions.

In comparing the average crop production of potatoes in the United States with that of Great Britain, one can not but be impressed with the fact that, generally speaking, we have much yet to learn before we can raise our average to that of that country. During the years 1901 to 1910, inclusive, the average acre yield in Great Britain was approximately 200 bushels, while that in the United States was not quite 93 bushels.

Of the many causes which produce a low average potato yield in this country, poor seed is thought to be important. The American potato grower pays too little attention to his seed potatoes. European growers pay very strict attention to the quality and quantity of seed they use. This has led to the differentiation of the potato industry into seed and crop specialists. The seed specialist makes a business of producing high-quality seed, while the crop specialist produces a high-grade table potato. Until rather recently no such differentiation, at least to any marked extent, could be claimed in this country. However, with the adoption of seed-potato inspection and certification in California, Oregon, Washington, Idaho, Colorado, Wyoming, Nebraska, North Dakota, Minnesota, Wisconsin, Michigan, Ohio, Pennsylvania, New York, Maryland, New Jersey, New Hampshire, Vermont, and Maine, groups of seed-potato growers are gradually being evolved. Sufficient progress has thus far been made in seed-potato inspection and certification to demonstrate their value to the potato industry. A further stimulus to those who are engaged in the production of seed potatoes is the increasing demand for good seed stock at prices which are sufficiently remunerative to well repay the grower for the extra care given to the crop.

WHAT CONSTITUTES GOOD SEED.

The question of what constitutes good seed is a vital one, and possibly no two persons would fully agree in every particular upon this point. Good seed may be defined as follows: Somewhat immature tubers—reasonably uniform in size and shape, with skin bright and free from scab—and firm and sound, with first sprouts just starting. Seed of such quality when given suitable cultural conditions can be relied upon to produce a remunerative crop, other things being equal. If it were possible to plant the entire potato acreage of the United States with first-class seed stock in any given year the total production would be increased from 10 to 25 per cent. Based on the average production for the 5-year period, 1913 to 1917, this increase would represent from 36½ to 91½ million bushels, or an increase in money value of $32,704,000 to $81,984,000.

PURE SEED.

The importance of securing pure seed of a given variety is best appreciated by the southern truck grower, who at the present time is practically dependent on northern-grown seed potatoes for his early crop. It frequently happens that Irish Cobbler seed potatoes as obtained from Maine have anywhere from 5 to 10 per cent, or even more, of mixture. Generally this mixture is of a much later maturing variety. The trucker plants this seed very early, much of the planting in the Norfolk trucking region being done in the latter half of February. At this season of the year there is little warmth in the soil; hence, the later maturing varieties are slower in starting into growth than is the earlier maturing Irish Cobbler. The result is an uneven germination, and few, if any, tubers of the later varieties have set when those of the Irish Cobbler are ready for the early market. The grower aims to harvest as soon as most of the tubers have reached a merchantable size. It requires little imagination to see that the grower is a direct loser in proportion to the amount of mixture in the seed planted. If his yield is 60 to 90 barrels per acre, with a 5 per cent mixture he has sustained a loss of from 3 to 4½ barrels, or 6 to 9 barrels if a 10 per cent mixture was present. Usually the price of early potatoes ranges from $3 to $5 per barrel, the highest price being obtained for the first lots harvested. Assuming that the first half of his crop is marketed at an average price of $4 a barrel, allowing 40 per cent of the gross receipts for production, package, transportation, and commission charges, the grower has sustained a net money loss of $7.20 to $21.60 per acre. The loss on the remainder of the crop, while relatively smaller, is by no means insignificant.

SEED FROM PRODUCTIVE PLANTS.

Comparatively little attention has as yet been given to the subject of the productiveness or unproductiveness of certain strains of plants within a variety. It is believed that this is a very important factor in the production of large yields, as in any variety, if studied closely, many unproductive plants may be found. This assumption is amply substantiated in the results secured from investigations conducted by the Department of Agriculture. Certain selections were made from strong and weak plants which were being grown on the tuber-unit basis. A record was made of the number and weight of the large and small tubers in each selection, and from these five of the best were selected for planting. The accompanying data give the average yields the second season from the strong and weak plants of the 12 varieties studied:

Strong tuber units = 3.28 pounds of primes; 1.18 pounds of culls. Total, 4.46 pounds.

Weak tuber units = 0.20 pound of primes; 0.51 pound of culls. Total, 0.71 pound.

The strong plants gave more than 16 times as large a yield of primes or merchantable tubers and only a little over twice as many culls as the weak plants. The proportion of small tubers would, without doubt, have been materially reduced if the vitality of the low-yielding plants had not been so weakened that in many instances no tubers were produced. These weakened plants were in many cases affected by the disease described by W. A. Orton [1] as the "curly dwarf." This is a hereditary disease, which largely can be eliminated by the method of tuber-unit selection.

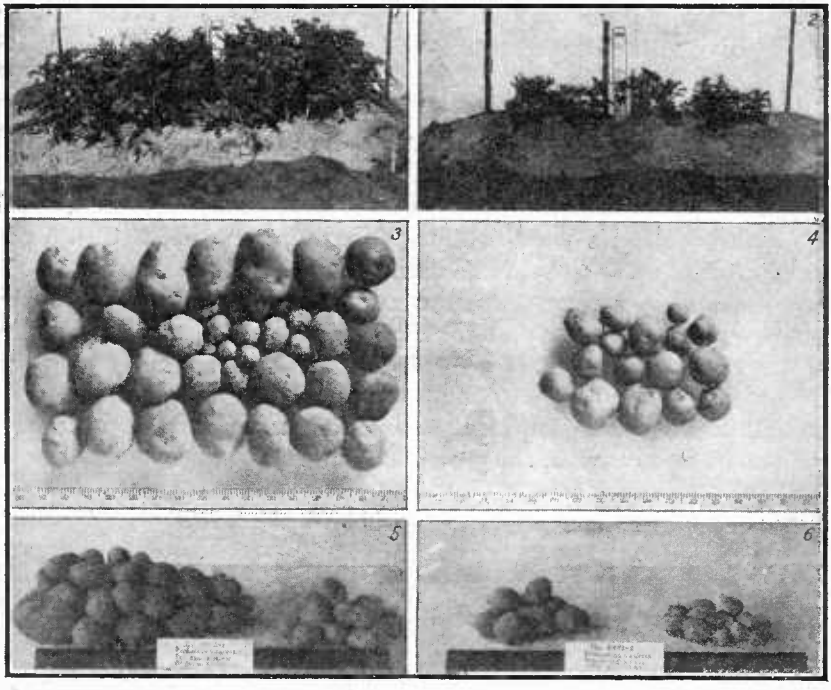

FIG. 5.—Strong and weak tuber units of the Gold Coin variety of potatoes: Nos. 1 and 2 represent strong and weak tuber units; Nos. 3 and 4 represent yields from tuber units Nos. 1 and 2; Nos. 5 and 6 represent yields from the second year's selection from five tuber units of Nos. 3 and 4.

It was found also that the average weight of the large tubers from the strong plants was 5.3 ounces as against 3.8 ounces from the weak ones, while in the case of the small tubers the weights were 1.7 and 1.1 ounces, respectively.

The photographs shown in figure 5 represent strong and weak tuber units of the Gold Coin variety of potatoes. Nos. 1 and 2 show the units as they appeared in the field when the crop from the first selection was harvested. Nos. 3 and 4 show the tubers pro-

[1] Orton, W. A. Leaf-roll, curly-leaf, and other new potato diseases. (Abstract.) *In* Phytopathology, v 3, p. 69. 1913.

duced by each of these units, and Nos. 5 and 6 show the yield from the second season's selection from five tuber units of the previous year's crop. Nos. 1, 3, and 5 represent the strong plants, and Nos. 2, 4, and 6 the weak plants. The average yield from these plants for the two seasons was as follows:

Strong plants = 3.2 pounds of primes; 1.77 pounds of culls. Total, 4.97 pounds.
Weak plants = 0.2 pound of primes; 0.68 pound of culls. Total, 0.88 pound.

The two groups of tubers in Nos. 5 and 6, figure 5, represent the primes and culls. All tubers weighing 3 ounces or more were classed as primes, while all under this weight were considered culls.

The accompanying diagram (fig. 6) presents the differences in yield in a striking manner.

In considering the results of this investigation it should be borne in mind that a comparison of two extremes simply illustrates in a more forcible manner the desirability of securing seed from vigorous, healthy, and productive plants.

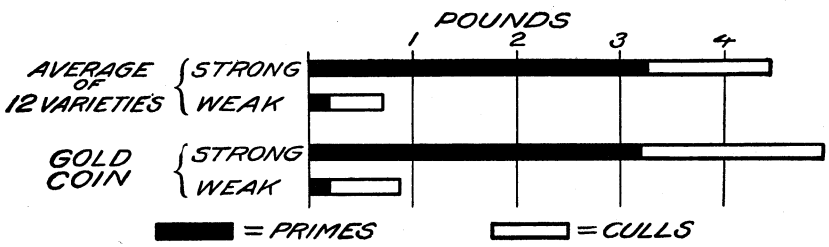

FIG. 6.—Diagram showing the average yields from strong and weak tuber units.

The investigations of Waid [1] at the Ohio Agricultural Experiment Station clearly demonstrate the superiority of selected over unselected seed. Waid compared seed from productive plants with that from unselected stock and from low-yielding plants. The average yield of 100 hills during the seasons of 1904, 1905, and 1906 was as follows:

High-yielding seed	138 pounds.
Unselected seed	110 pounds.
Low-yielding seed	73 pounds.

The gain in favor of the high-yielding plants over the unselected and low-yielding plants was 25.4 and 89 per cent, respectively.

While the results secured by Waid are doubtless higher than might be expected under average conditions, they emphasize the value of seed selection. Some interesting data have been published by Burritt [2] upon the methods pursued in seed selection and also of the yields secured by T. E. Martin, of West Rush, N. Y. Mr. Martin

[1] Green, W. J., and Waid, C. W. Potato investigations . . . Ohio Agr. Exp. Sta. Bul. 174, p. 249–289, 18 fig. 1906.

[2] Burritt, M. C. A successful New York farm. U. S. Dept. Agr., Farmers' Bul. 454, pp. 16–22, fig. 6. 1911.

maintains a seed-selection plat from which all weak or imperfect plants are rigidly removed. At harvesting time the crop from the selection plat is sorted into two grades, "specials" and "selects." The specials must weigh not less than 12 ounces each, must have well-developed seed and stem ends, and, furthermore, must be true representatives of the variety grown, which is exclusively the Sir Walter Raleigh. The selects include all that do not pass as specials but that are of good size and shape, all unshapely or undersized tubers being discarded. The specials are used to plant the seed plat the ensuing season and the selects to plant the general field crop.

The value of the method is well attested by the crops produced. The average production on an 18-acre basis for the nine years, 1901 to 1909, was 282 bushels per acre. The highest seasonal yield during this period was 417 bushels, and the lowest 233 bushels. These yields are being secured in a locality where the general average is approximately 150 bushels per acre.

IMMATURE SEED.

The superiority of immature over mature tubers for seed is not as yet recognized by the American potato grower. The European growers, on the other hand, have long realized that, other things being equal, larger crops can be produced from immature seed than from mature seed. The results of some experiments conducted on the trial grounds of Sutton & Sons, Reading, England,[1] support this assumption.

The average production of eight varieties grown from 12 sets of immature and mature seed was as follows:

Immature seed = 212 pounds of table stock; 49 pounds of seed; 9½ pounds of culls. Total, 270.5 pounds.

Mature seed = 105 pounds of table stock; 39 pounds of seed; 12½ pounds of culls. Total, 156.5 pounds.

Expressed in percentage, there was a difference in favor of immature seed of more than 100 per cent for table stock and a total difference of over 72 per cent.

In an unconscious way immature seed is being used by the American grower to a very large extent, especially by the southern truck grower when he uses northern-grown seed for his early crop. This seed, especially that obtained from northern Maine, is more or less immature when harvested. Recent studies by the office of Horticultural and Pomological Investigations on the relative values of immature and mature seed would seem to indicate that the vigor of the seed is perhaps quite as largely dependent upon the weather prevailing during the period in which the tubers were formed as upon their immaturity. For example, if the tubers were developed during

[1] Sutton & Sons. Potato Demonstration, p. 22. 1906.

a hot dry period the vigor of the stock is noticeably less than when the weather was cool and there was an abundant supply of moisture. It is believed that a reasonable degree of immaturity is desirable. Very immature tubers have always failed to produce a good crop. Greater attention should be given to the influence of the climate on seed potatoes than has heretofore been accorded to it.

UNIFORMITY IN SIZE AND SHAPE OF TUBERS.

Under normal conditions of growth a large proportion of the present-day commercial varieties are very variable in size and shape of tuber. To some extent both size and shape are determined by the character of the soil, rate of planting, fertilization, and cultural care given the growing crop. Inheritance, however, plays a very important part. Most varieties contain within themselves distinct varietal strains which when isolated are much more uniform in respect to size and shape than the variety itself. Other things being equal, the variety or varietal strain that produces the greatest number of fair-sized shapely tubers and the smallest number of ill-shaped and small tubers should prove the most valuable, because it involves less waste to both the grower and the consumer. It is particularly important at present that such strains be developed, because there is an increasing demand for fancy table stock to satisfy the requirements of a large and discriminating class of consumers who are insisting on greater uniformity in size and shape and are willing to pay a premium on such grades.

DEVELOPMENT OF HIGH-GRADE SEED POTATOES.

The successful production of high-grade seed potatoes is very largely dependent upon the following factors: (*1*) *Starting with a good strain;* (*2*) *the proper treatment of the seed;* (*3*) *thorough preparation and proper fertilization of the soil;* (*4*) *the following of the best cultural practices, including protection against insect and fungous pests;* (*5*) *the elimination of all mixtures and all diseased or weak plants; and* (*6*) *the careful harvesting and proper storage of the crop.*

SECURING A GOOD STRAIN OF SEED.

If the strain of seed you are using is lacking in vigor, it is generally advisable to discard it and purchase a new lot from some reliable grower whose stock you have reason to believe is superior to yours. This suggestion is made as the result of a rather wide experience in trying to improve poor strains of potatoes through selection methods. Such attempts have usually resulted in failure, and it is felt that as a rule much more satisfactory progress can be made by starting with a new strain. Further improvement can usually be secured through selection.

SEED-POTATO IMPROVEMENT BY SELECTION.

The improvement of seed potatoes by selective processes has long engaged the attention of the potato grower. Recent experimental evidence seems to indicate that the possibilities of improving potato seed stock by selective processes alone are not as great as many writers upon this subject have claimed. To those who have devoted much time and effort to the improvement of the potato by selection, it would appear as if the chances of finding superior yielding true-to-type strains within a variety are not as great as has been believed. The chief advantages to be derived from seed-potato selection practices are the elimination of diseased and weak plants and the removal of varietal mixtures.

IMPROVEMENT PRACTICES.

Five improvement practices may be used in securing a high-yielding and commercially desirable strain of potatoes: (1) The tuber-unit method, (2) hill selection, (3) mass selection, (4) field roguing, and (5) strain testing.

In the previous editions of this bulletin considerable emphasis was laid upon the tuber-unit method of seed potato improvement; subsequent experiences of the writer and others have indicated that this method is not as satisfactory or as practical in operation as the other four methods suggested. It is thought desirable, however, to briefly describe the tuber-unit method because some of its processes are applicable to other selection methods.

TUBER-UNIT METHOD.[1]

The tuber-unit method, as now generally understood, consists in selecting from the seed bin before planting time a considerable number of the most perfectly shaped tubers of from 6 to 8 ounces in weight. When planted, these tubers are quartered, as dropped, into four as nearly equal parts as possible. This is done by splitting the bud-eye cluster in each direction from seed to stem end of the tuber. In other words, the tuber is cut through its longitudinal axis. The four pieces of each tuber are dropped consecutively in the row at a distance of from 10 to 12 inches apart in the furrow. All tubers showing discoloration of the flesh or other evidence of disease should be rejected. By allowing an additional spacing between each set of fours, the four plants from each tuber are definitely isolated from adjoining ones and the grower can readily observe any variation in vigor and uniformity between the various units planted. This method also enables him to detect any mixtures that may occur in the variety. All mixtures should at once be removed. By marking

[1] For further information concerning the arrangement of a tuber-unit selection plat and a convenient system of note taking, see Stuart, William, The "tuber-unit" method of seed-potato improvement. U. S. Dept. Agr., Bur. Plant Indus. Cir. 113, pp. 25–31, 2 fig. 1913.

the units which appear to be most uniform in size, vigor, and type when the plants are still in vigorous growth, the first step in selection has been accomplished. At digging time the product of each unit is separately harvested and a further selection made from the marked units of all units or tubers which most nearly approach the size, shape and smoothness desired. These selected tubers should be numbered with both field and unit numbers and separately placed in small sacks, preferably cotton or burlap, and stored to await further examination. The final examination should consist of notes on the number and weight of merchantable and unmerchantable tubers and their general conformity in size, shape, and smoothness to the type desired. From each of the units retained 10 of the best tubers should be selected for the next season's planting.

It is desirable to maintain the study of each selection on the tuber-unit basis the following season, because it permits a more accurate comparison of the behavior of each. The 10 selected tubers from each original unit will give 40 plants for study the second year. All selections which do not produce a reasonably uniform lot of plants should be marked for rejection. At harvest time the progeny of each selection should be kept by itself and the same data recorded as those taken on the crop grown from the original tuber unit. Only the product from such 40-hill rows as meet the most rigid requirements should be retained. The further conduct of the work will consist in the multiplication of the selected strains for field planting and the elimination of weak plants.

HILL SELECTION.

The hill-selection method consists in marking the most promising plants during the growing season and at harvesting time saving only those which give greatest promise. The progeny of each hill should be kept separate and the same data taken as outlined for the tuber unit. Plant on the tuber-unit or progeny-row basis the following season. For the sake of uniformity a definite number of tubers (five or more) should be planted from each hill selection. From this point on, follow the methods given in tuber-unit work.

MASS SELECTION.

Mass selection differs from hill selection in only one respect, which is that the tubers from the individually selected plants are not kept separate. Generally those who practice mass selection do not go to the trouble of marking promising individual plants during the growing season, but simply go through the field before harvesting the whole crop and dig by hand as many plants as may be desired to secure the necessary quantity of seed that show the desired vigor and stem characters thought to be correlated with productiveness, trueness to type, and uniformity in size of tubers of the particular variety grown.

FIELD ROGUING.

Improvement of the seed stock through field roguing consists in the removal of all diseased, weak, off-type, or varietal-mixture plants during the growing season. The successful removal of such plants does not necessarily involve an intimate knowledge of the various diseases affecting the potato, but it does require that the person doing the roguing be able to tell whether a plant is normal or abnormal in appearance. A sufficient field area should be rogued the first year to provide the quantity of seed necessary to plant the full acreage to be grown the ensuing season. The area to be rogued should be gone over at least three times during the growing season, to insure the removal of all plants affected with transferable diseases, such as mosaic and leaf-roll, as soon as their presence can be detected. In the field-roguing method no attempt is made to select the progeny of individual plants at harvesting time, the whole crop being dug and all desirable seed stock gathered and stored in bulk.

STRAIN TESTING.

The improvement of seed potatoes by the strain test, or, as it might more properly be termed, the "source-of-seed test" method, consists in securing as many as possible desirable lots of seed stock of the same variety from different growers throughout a given district or State, or even from various States, and carefully studying their behavior when grown side by side under identical soil and cultural conditions. Experimental studies by this method of seed improvement have demonstrated that some lots or strains of seed stock are far superior to others; in fact, differences in yield of more than 100 bushels per acre have been noted between the lowest and highest yielding strains. Furthermore, it has been conclusively demonstrated by numerous trials that these yields were not accidental, but that in practically every instance the high-yielding strains have consistently given larger yields wherever tested.

The improvement of seed stock by this method does not consist in the actual isolation and development of a strain from a given variety, but rather in locating, as it were, by comparative tests the really superior sources of seed stock. The actual improvement accomplished is measured by the success attending one's efforts in getting live, up-to-date growers to discard their inferior strains and purchase the superior one, as shown by the tests made.

The practical operation of such a movement may be best emphasized by stating that in 1921 over 100 potato growers in Wisconsin grew seed stock of a superior strain of Triumph potatoes located in this manner in 1918.

It should be remembered that whatever selection practice is pursued the fields devoted to the production of high-quality seed must be carefully rogued if the vigor of the seed stock is to be maintained.

RELATIVE MERITS OF THE PRECEDING PRACTICES.

In the preliminary discussion of seed-potato improvement in this bulletin it is intimated that the chance of securing a superior strain of a commercial variety of potato through selective processes is not as great as earlier writers on this subject have claimed. A careful consideration of all the experimental evidence thus far presented would seem to justify the conclusion that the tuber-unit method of seed-potato improvement does not afford as satisfactory a starting point for selection work as the hill-selection method. The evidence at hand would also seem to indicate that neither of these practices is to be commended to the average grower of seed potatoes, as both methods involve an expenditure of a greater amount of time and effort in properly observing the details necessary to their successful application than can reasonably be expected of such a grower. The tuber-unit and hill-selection methods can only be recommended to those growers who have ample time or means to undertake these studies and to those experiment-station investigators who have the facilities necessary for carrying on such work.

The "mass-selection" and the "field-roguing" methods are more nearly adapted to the average grower, as neither method involves the growing and keeping separate of a large number of individual selections. Both are so simple of execution that any person of ordinary intelligence can practice them.

Strain testing involves a somewhat more elaborate plan of operation, in that it requires the purchasing and growing of several strains of a given variety under as nearly identical conditions as it is possible to supply. This method of seed-potato improvement may be best undertaken by the type of men suggested for the conduct of the tuber-unit and hill-selection systems. The average grower should avail himself of the findings of those engaging in strain testing and purchase his seed from those growers having the most desirable seed stock, as demonstrated by such tests.

REQUIREMENTS FOR SUCCESS.

The only requirements for the successful practice of the first two methods of seed selection are a reasonable degree of painstaking effort on the part of the grower, some 12-inch garden labels, a small pair of balances, a sufficient number of suitable small sacks, and a safe place in which to store the selected tubers until required for the next season's planting. In addition to this, the grower should have a breeding plat in which each season's selections can be developed up to the point of field-planting stock.

The selection or breeding plat need not necessarily be separated from the general field plat. In most cases it can be more conveniently handled if it is a part of the regular field. All that is required is to set aside as many rows as may be necessary to plant the selected tubers. These should be preferably on one side of the field, so that they can

be more readily observed. The planting furrows may be opened and the fertilizer distributed with the potato planter by removing the disks and setting the plow a trifle deeper. If a plow is used in covering, care should be exercised to avoid displacing the seed pieces.

SEED TREATMENT.

It is impossible to produce high-grade seed potatoes if the seed planted is infected with disease organisms capable of infecting the crop. The disinfection of the seed potatoes is therefore necessary if the best results are to follow. The two diseases for which seed potatoes are ordinarily treated are common scab and black scurf or Rhizoctonia. The two disinfecting agents recommended for such treatment are formalin and corrosive sublimate (mercuric chlorid or bichlorid of mercury). Formalin is as effective against the common scab as corrosive sublimate, but it does not give as good results in the destruction of the black-scurf fungus. When the latter is present on the tubers corrosive sublimate should be used. The formulas recommended for these two disinfectants are as follows:

(1) Formalin, 1 pint.
Water, 30 gallons.

(2) Corrosive sublimate, 4 ounces.
Water, 30 gallons.

If the formalin treatment is selected the seed potatoes should be soaked in this solution from one-half to 1½ hours. Recent experiments by Dr. I. E. Melhus indicate that an immersion of the seed potatoes for 2 minutes in a formalin solution of twice the strength mentioned heated to a temperature of 122° F. and covered for an hour after their removal from the hot liquid is just as effective as the longer treatment in the cold solution.

When the corrosive-sublimate solution is used, the length of the immersion should be governed by the condition of the tubers and their freedom from or the severity of the black-scurf infection. If the tubers are dormant and they are more or less infected with the sclerotia of the black scurf the treatment may be prolonged to 1½ or 2 hours. If they have started to germinate and are reasonably free from black scurf the period may be shortened to a half hour or less.

The treated tubers should on no account be allowed to come in contact with such receptacles as old sacks and barrels in which diseased seed has been handled, as they are almost certain sources of reinfection. For further information, consult Circular No. 3 of the Office of Cotton, Truck, and Forage Crop Disease Investigations of the Bureau of Plant Industry.

PREPARATION AND FERTILIZATION OF THE SOIL.

Strong, vigorous plants can not be produced on land that has been poorly prepared or that is deficient in available plant food. Seed potatoes should be grown on land that has been deeply plowed and

thoroughly prepared to receive the seed. It should be well supplied with organic matter and available plant food. A clover or alfalfa sod furnishes the organic matter and considerable of the plant food. Barnyard manures or commercial fertilizers, or both, will supply the additional plant food necessary to produce a good crop.

CAREFUL CULTURAL PRACTICES.

The vigor of the seed stock produced is to a large extent dependent on the care given to the growing crop. Uniformity in the size of the tubers is to a large extent governed by the rate of planting. Closer planting should be practiced in the growing of seed than of table stock. Some growers in Aroostook County, Me., space their rows from 32 to 36 inches apart and the plants in the row 8 to 12 inches. The crop should be cultivated as frequently as may be necessary to provide the most suitable growing conditions.

Every effort should be made to protect the plants from injury by insect or fungous pests. Leaf-eating insects can be effectively controlled if the plants are thoroughly sprayed with arsenical poisons; sucking insects with contact solutions, such as kerosene emulsion and nicotine; and fungous diseases, such as the early and late blights, with Bordeaux mixture. In every operation it should be remembered that whatever contributes to the health of the plant increases the vigor of the seed stock produced.

ELIMINATION OF VARIETAL MIXTURES AND DISEASED OR WEAK PLANTS.

The vegetable-seed growers employ the term "roguing" to denote the process of removing all mixtures or off-type plants from the seed plat. As this term, when understood, is a brief and yet sufficiently descriptive way of indicating the process of eliminating all undesirable plants or "rogues," it is proposed to use it in this connection.

It is an easy matter to rogue a seed-improvement or selection plat during the growing season. Varietal mixtures are more easily detected when the plants are in bloom. Weak plants are usually apparent in the early stages of their growth, as are also certain types of diseases, such as mosaic and black-leg, although both may appear later. Plants infected with Rhizoctonia and Fusarium are usually not apparent until the latter part of the growing season. It is evident from these statements that in order to rogue the seed plat thoroughly it is necessary to make two or three examinations of the field or plat during the growing season. Further roguing should be done when the crop is harvested by discarding the progeny of all low-producing plants.

CAREFUL HARVESTING AND PROPER STORAGE OF THE CROP.

The average grower does not fully appreciate the importance of using every means to prevent the mechanical injury of the tubers during the process of harvesting and storing them. If the crop is grown on land containing a plenteous admixture of small stones the tubers are almost certain to be more severely injured in harvesting than when grown in a sandy loam soil. Hand digging is not always feasible, but it is believed that where small stones abound in the soil it will be desirable to harvest the home seed plat by hand. Much injury will be avoided if the seed stock designed for planting the field plat of the ensuing year is picked directly into crates in which it is allowed to remain throughout the storage period.

The storage conditions necessary to insure vigorous seed at planting time are more easily provided in the North than in the South. In the former region a well-constructed cellar, pit, or cave serves reasonably well. The main thing is to keep the room temperature sufficiently low to retard germination. The ideal seed tuber is one which has not wasted any of its stored-up energy by excessive loss through sprouting. (Fig. 7.) It should be firm, with the first sprouts just showing. Such tubers can be depended upon, if suitable conditions prevail, to start quickly when planted and to make a vigorous growth.

The general practice among southern growers of securing seed from the North involves in the absence of suitable storage conditions one of two things: Either getting the seed potatoes late in the fall and holding them over in dugouts, pits, or cellars, with consequent sprouting before planting, or the risk of having the seed chilled, frozen, or overheated while in transit in midwinter. In the writer's opinion the greatest need of the large southern truck grower at present is that of suitable storage facilities for handling fall shipments of seed potatoes. As a purely economic proposition the proposed change ought to commend itself. In probably nine cases out of ten the difference in first cost of these potatoes as between fall and midwinter shipments would more than offset the extra cost of storage, while the added security from danger of chilling or freezing the shipment would still further compensate the grower.

For further particulars on storage, consult Farmers' Bulletin 847, entitled "Potato Storage and Storage Houses."

LARGE COMPARED WITH SMALL SEED TUBERS.

In seasons of short production and consequent high prices for table stock, the question is frequently raised as to the advisability of using the small unsalable tubers for seed. The answer to this question is

found in the data secured from the strong and weak plants. A comparison of the merchantable and unmerchantable tubers produced shows that the strong plants produced over 16 times as great a weight of large tubers as the weak plants, but only a little more than twice

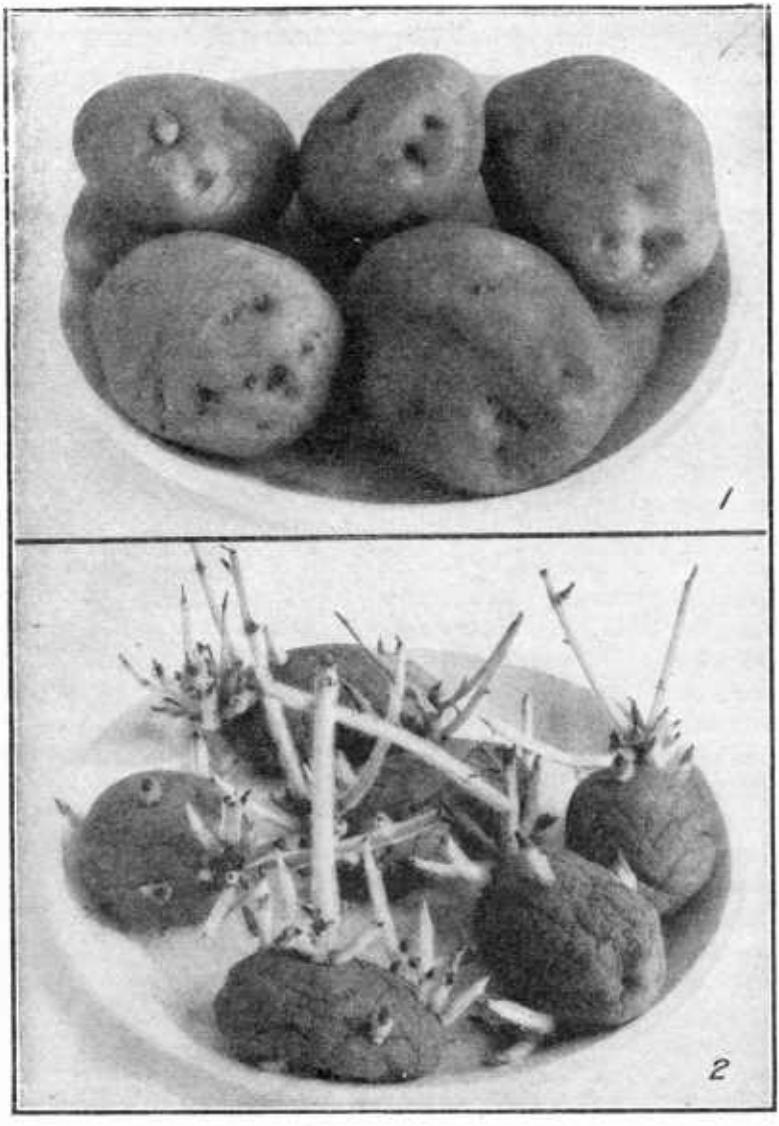

FIG. 7.—Potatoes for seed purposes, showing different stages of germination: 1, Desirable; 2, undesirable.

as great a weight of small tubers. It was found also that the average weight of the large tubers from the strong plants was 5.3 ounces, as against 3.8 ounces from the weak ones. The small tubers, or culls, from the strong plants averaged 1.7 ounces, as against 1.1 ounces

from the weak ones. From these data it is not difficult to see that in the use of small tubers one would inevitably and unwittingly select a large proportion of his seed from the unproductive and weak plants and a relatively small proportion from the productive and vigorous ones. In this connection Ballou[1] makes the following statements regarding the use of large and small tubers for seed:

The use of large tubers gives—

(*a*) A very heavy, perhaps almost total, percentage of the high-producing strains.

(*b*) A heavy percentage of the average or moderate-yielding strains.

(*c*) A very small percentage of the inferior or low-producing strains.

The use of small potatoes gives—

(*a*) A very insignificant percentage of the superior or high-yielding strains.

(*b*) A small percentage of the average or moderate-yielding strains.

(*c*) A very heavy, almost total, percentage of the low-yielding or inferior strains.

The use of small seed potatoes is only permissible when they are known to have been produced by strong, healthy, and productive plants. It is never advisable to use small tubers from the general mass produced from unselected stock.

WHOLE COMPARED WITH CUT SEED.

Considerable attention has been paid to the subject of whole versus cut seed at various times by the State agricultural experiment stations. The data accumulated in these investigations are for the most part conflicting in so far as they pertain to the use of whole seed. In general, the data show that within reasonable limits the larger the seed piece planted the larger is the crop produced. English and Scotch potato growers almost without exception plant whole tubers. The seed used usually runs from 1¼ to 2¼ inches in diameter, being screened out of a crop which as a rule has been grown especially for seed purposes. They are harvested before they are mature, and but a relatively small proportion of the crop exceeds the size mentioned. These growers believe that an earlier and more vigorous growth is secured from immature tubers.

Some of the reasons why European growers have adopted whole seed and are succeeding in producing profitable crops are as follows: (1) They are assured of an almost perfect stand; (2) there is greater freedom from disease; (3) the almost universal practice of germinating their seed before planting insures a minimum number of sprouts; and (4) the greater fertility of their land makes large yields of medium-sized tubers possible.

Some of the reasons for failure in the use of whole seed in this country follow: (1) The use of small tubers from unselected stock

[1] Ballou, F. H., and Gourley, J. H. I. The status of the potato growing industry in Ohio. II. Seasonal notes on potatoes. Ohio Agr. Exp. Sta. Bul. 218, p. 587. 1910.

and (2) the development of too many sprouts, with a consequent large set of tubers, which, owing to lack of thorough preparation of the soil, scant plant food, and moisture, do not reach a marketable size, at least in sufficient numbers to produce a profitable crop. The development of too many sprouts comes about through planting tubers in a dormant condition, which under favorable soil temperature and moisture starts almost every bud into growth.

Scotch and Irish potato growers plant not less than 37 bushels of seed per acre, and frequently this quantity is greatly exceeded. The American grower, on the other hand, plants from 9 to 16 bushels per acre, with an average of 9 to 11 bushels. It is believed that the average potato production of the United States would be very materially increased if a larger quantity of seed were used.

SUMMARY.

The production of high-grade seed potatoes should be regarded as a special business.

Good seed is a determining factor in the production of maximum crops of potatoes.

The use of high-grade seed would increase the returns from the potato crop of the country by many millions of dollars.

Good strains of seed may be obtained by the tuber-unit, hill-selection, mass-selection, field-roguing, or strain-test methods through the process of elimination.

Like produces like. If tubers from unproductive or weak plants are planted, a poor harvest will be reaped. Use seed from productive plants.

Purity of seed stock is an essential quality of good seed. Serious losses are sustained by the grower through mixtures.

Good seed can not be produced unless the growing plants are well cared for.

A more liberal use of good seed would materially increase the average production per acre.

All seed should be disinfected before planting.

Good storage facilities are essential to insure sound, firm seed at planting time.

How To Do It

DO YOU WANT practical suggestions on how to build a silo, a hog house, a poultry house, a potato-storage house, or how to make a fireless cooker, or other farm home convenience? Are you seeking ideas on how to prepare vegetables for the table, how to care for food in the home, how to bake bread and cake and other appetizing foods in an efficient and economical manner? Is there some practical question about your corn or wheat or cotton or other crops, or about your poultry or live stock, to which you are seeking an answer? The answers to thousands of such questions, and practical suggestions for doing thousands of things about the farm and home, are contained in over 500 Farmers' Bulletins, which can be obtained upon application to the Division of Publications, United States Department of Agriculture, Washington, D. C.

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